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Revised Lithostratigraphic Nomenclature of the Pottsville and Allegheny Groups (Pennsylvanian), Clearfield County, Pennsylvania

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COMMONWEALTH OF PENNSYLVANIA

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PREFACE

The sequence of sedimentary (layered) rocks in Pennsylvania is as much as 30,000 feet thick. Clearly, if one wishes to discuss and describe the various parts of this great thickness of rock, it is necessary to subdivide it into smaller units. Geologists have devised a system of subdivision which consists of a series of vertically layered smaller units arranged sequentially from top to bottom. Each unit is given the name of some geographic locality at or near which it is well exposed.

It is most important that these subdivisions be defined as clearly and accurately as possible. The confusion and misinterpretation which follows from poorly defined units is carried over into other studies with the results that individuals using those studies are frequently unsure as to what part of the sedimentary sequence is being considered.

This causes errors not only in theoretical studies, but costly economic misinterpretations, such as the miscorrelation of various coal seams or limestone beds.

To minimize the possibility of inaccuracy, a formalized procedure has been established to be followed in creating new subdivisions. This short report is a redefinition of existing units with a formal designation of new units.

The rocks involved in this nomenclatural revision are part of the coal-bearing sequence of western Pennsylvania. These rocks include the Mercer coals, Clarion-Brookville coals, lower Kittanning coals, middle Kittanning coal, upper Kittanning coal, lower Freeport coal, upper Freeport coal, as well as several valuable clay beds and other economically important units.

It is believed that these new units will have the following important advantages:

1. The new units are more accurately and exactly defined than older units.
2. They will provide more detailed subdivision of the coal measures on the new 7½ - minute (1 inch = 200 feet) quadrangle maps.
3. The surface traces of the boundary lines between these units on a geologic map represent exactly the location of most of the important coal and clay beds.

Industry, geologic researchers, and other students of geology should evaluate this proposed nomenclature; their findings will be a true test of the acceptability of the newly defined units.

CONTENTS

ILLUSTRATIONS

FIGURES

Revised Lithostratigraphic Nomenclature of the Pottsville and Allegheny Groups (Pennsylvanian), Clearfield County, Pennsylvania

By
William E. Edmunds

ABSTRACT

Seven new formations are erected for use in dealing initially with the stratigraphy of the lower part of the Pennsylvanian (Alleghenian and Pottsvillian) rocks of Clearfield County, Pennsylvania. Type sections are presented. The new formations together with the presumed relation to the Allegheny and Pottsville Groups can be generalized as follows:

Allegheny Group (base Clarion no. 1 coal to top upper Freeport coal).
- Glen Richey Formation (base lower Freeport coal to top upper Freeport coal).
- Laurel Run Formation (base upper Kittanning coal to base lower Freeport coal).
- Mineral Springs Formation (base middle Kittanning coal to base upper Kittanning coal).
- Millstone Run Formation (base lower Kittanning no. 1 coal to base middle Kittanning coal).
- Clearfield Creek Formation (base Clarion no. 1 coal to base lower Kittanning no. 1 coal).

Pottsville Group (all Pennsylvanian rocks below Clarion no. 1 coal, base is the Mississippian - Pennsylvanian unconformity).
- Curwensville Formation (base of lowest Mercer underclay to base Clarion no. 1 coal).
- Elliott Park Formation (all Pennsylvanian rocks below the base of the lowest Mercer underclay; base is the Mississippian - Pennsylvanian unconformity).

PREVIOUS NOMENCLATURE

GENERAL NOMENCLATURE USAGE IN WESTERN PENNSYLVANIA

Since about 1900 the nomenclature applied to the lower part of the Pennsylvanian rocks of western Pennsylvania has been fairly well stabilized as to stratigraphic unit names and general sequence (Figure 1). The rank of the various units as well as some of the boundaries are less well established.

The following is an alphabetically arranged list of stratigraphic terms used since 1900 as units equivalent to formation rank or higher as defined

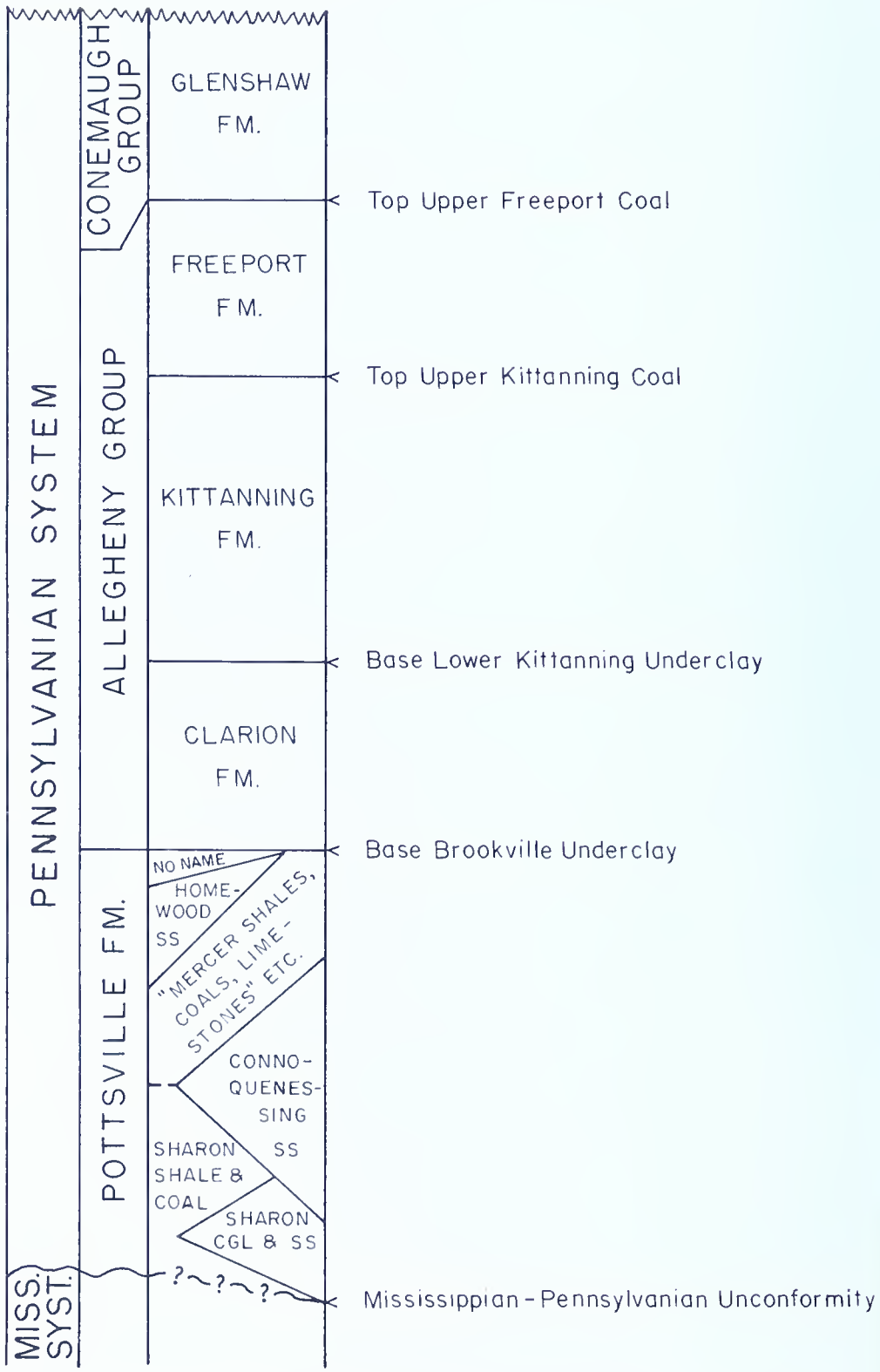


Figure 1. Commonly employed stratigraphic column for the lower part of the Pennsylvanian of western Pennsylvania.

in the 1961 Code of Stratigraphic Nomenclature (American Commission on Stratigraphic Nomenclature, 1961):

Allegheny (Group, Coal Group, Formation, Series, Coal Series);
Clarion (Formation, Coal Group, Member);
Conemaugh (Group, Formation, Series);
Connoquenessing (Sandstone, Formation, Member, Sandstone Group);
Freeport (Formation, Coal Group, Member);
Homewood (Sandstone, Formation, Member);
Kittanning (Group, Formation, Member, Coal Group);
Mercer (Formation, Member, Shale Member);
Olean (Conglomerate, Sandstone);
Pottsville (Group, Series, Formation, Conglomerate);
Sharon (Formation, Series, Coal Group, Member);
Vanport (Limestone, Formation, Limestone Member).

All of the above units are lithostratigraphic by initial definition and continued usage. Therefore, following the practice of the 1961 Code of Stratigraphic Nomenclature the chronostratigraphic term "series" and the ambiguous term "coal group" must be discarded.

"Allegheny"

The term "Allegheny" has been generally stabilized in Pennsylvania as including those rocks between the base of the Brookville underclay and the top of the upper Freeport coal. Various suggestions have been made to modify this usage, but none has been adopted in practice. The Allegheny has long been completely divided into formations and therefore holds group status.

The Allegheny Group is a heterogeneous sequence of lithologies defined by key beds. The upper key bed is the upper Freeport coal, which is widely and, probably, correctly identified. The lower key bed is the so-called Brookville coal and underclay which are not well understood, and are identified more or less speculatively from place to place.

"Pottsville"

The term "Pottsville" has been fairly well established in western Pennsylvania for many years. It includes all Pennsylvanian age rocks below the base of the Brookville underclay; its lower boundary being equivalent to the presumably ubiquitous Mississippian - Pennsylvanian unconformity.

The upper boundary of the Pottsville, being a key bed, is soundly defined in a theoretical lithostratigraphic sense; but, as mentioned in the section on "Allegheny", the Brookville coal and clay are not well understood or clearly traceable.

The use of an unconformity as the lower boundary is somewhat irregular in a strict lithostratigraphic sense. Because the lithologic contrast across the unconformity in some places is not pronounced, as where the Connoquenessing sandstone directly overlies the Pocono sandstone, it may be difficult to discriminate the boundary. Still there seems no practical alternative to the use of the unconformity as the boundary. The only other possibility would require setting up new formations which span the unconformity and include both Mississippian and Pennsylvanian age units in areas where lithologic contrast across the unconformity is not marked. The nomenclatural confusion resulting from such a practice would, however, seem to more than offset any advantage obtained from adhering closely to strict lithostratigraphic procedure. Where it is impossible to locate the unconformity, it would seem best to refer to those rocks by the names of the two adjacent, but undistinguishable, units undifferentiated (as Pocono-Pottsville undifferentiated).

Regardless of what class names have been appended to the Pottsville interval in the past, it has been only in the last several years that attempts have been made to completely subdivide the Pottsville of western Pennsylvania into formations, and thus technically qualify the Pottsville as a "group".

Williams (1960), in a generalization of the Pottsville in areas where there are no Pennsylvanian units below the lower Connoquenessing sandstone, broke the Pottsville into two formations. Williams' formations are only broadly defined, amounting essentially to the two Connoquenessing sandstones and the intervening Quakertown shales and coal as the lower formation and everything else above, up to the base of the Clarion - Brookville underclay, as the upper.

Carswell and Bennett (1963) and Poth (1963) also divided the Pottsville into four formations (Figure 2).

Shaffner (1963) mentions that the Pottsville is divided into Sharon, Connoquenessing, Mercer, and Homewood Formations; but does not define the units or utilize them in his text or diagrams.

"Conemaugh"

The Conemaugh has long been defined as those rocks extending from the top of the upper Freeport coal to the base of the Pittsburgh coal. Although frequently referred to as a series or group, the Conemaugh never rose above formation rank until subdivided into the Glenshaw and Casselman Formations by Flint (1965). The Conemaugh is a heterogeneous unit bounded by key beds.

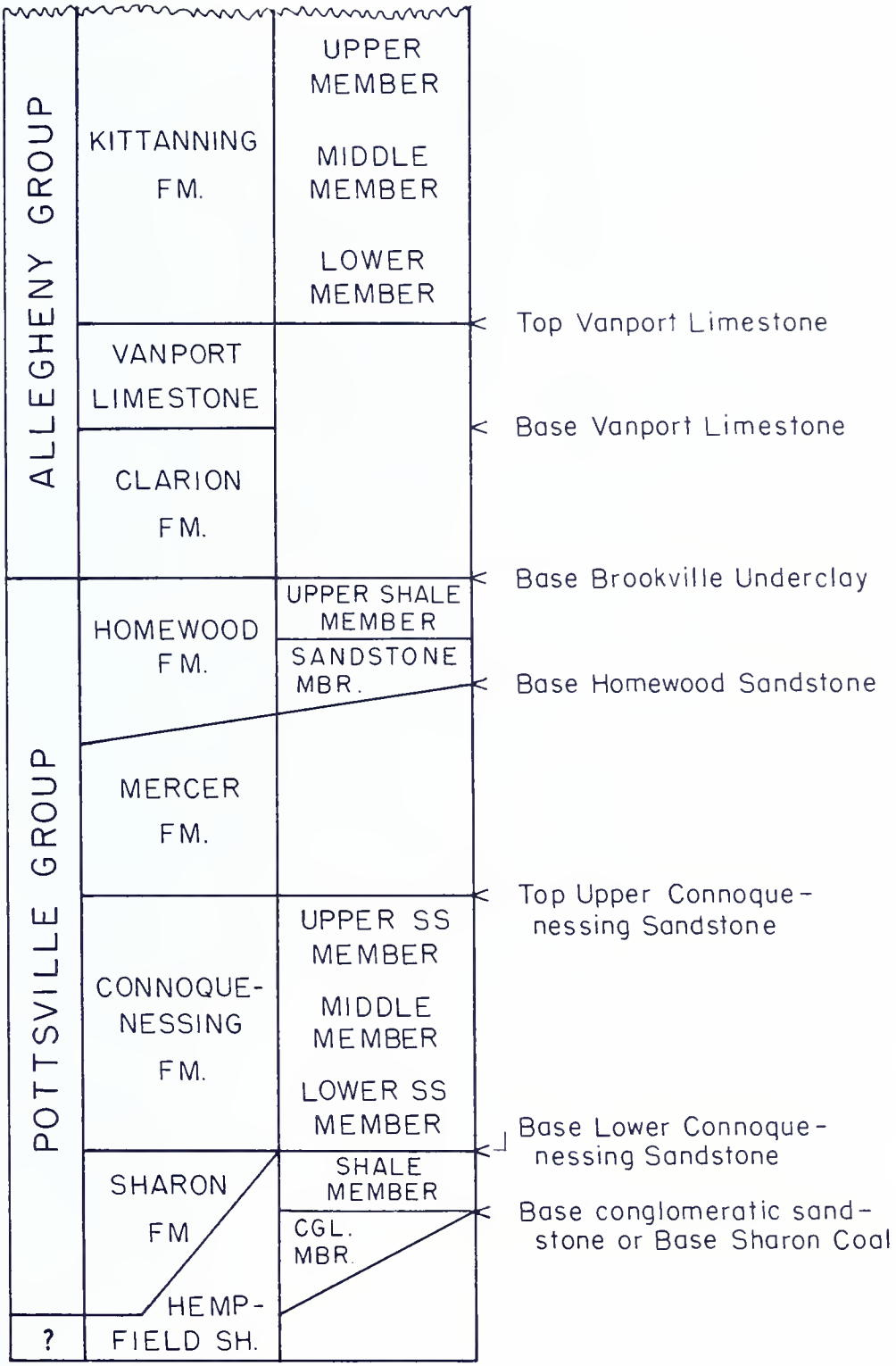


Figure 2. Stratigraphic column used by Carswell and Bennett (1963) and Poth (1963) for the lower part of the Pennsylvanian of western Pennsylvania.

"Clarion"

The Clarion is the lowest division of the Allegheny Group, and, as redefined in Ashley (1926), is considered as the rocks between the base of the Brookville underclay and the base of the lower Kittanning underelay. The Clarion has been customarily and logically classed a formation.

The Clarion Formation is a heterogeneous unit bounded by key beds. Some difficulties are connected with both the upper and lower limits. The nature and lateral correlations of the Brookville coal and underclay are not well understood, and identification of the Brookville horizon is usually rather tenuous.

Until recently the upper boundary was thought to be fairly clear. However, in Edmunds (1968) it has been demonstrated that the lower Kittanning coal of southeastern Clearfield County consists of four seams which merge into one thicker seam of coal to the southeast. Edmunds placed the upper boundary of the Clarion Formation at the base of the underclay below the lowest split (lower Kittanning no. 1 coal). In tracing these splits westward to Jefferson County, it has been found that while lower Kittanning no. 1 declined to a very thin, obscure coal, lower Kittanning no. 3 became the main mined lower Kittanning seam (in effect becoming in usage *the* lower Kittanning coal). If this trend continues, it is clear that the Clarion Formation as described farther west will have its upper boundary placed at the base of the lower Kittanning no. 3 underclay. This discrepancy between Edmunds' use and the customary use farther west is obvious.

In addition, another recent modification of the Clarion Formation was made by Carswell and Bennett (1963) and Poth (1963) wherein the Vanport Limestone and overlying units were separated from the Clarion Formation (Figure 2). Their Clarion Formation extends from the base of the Brookville underclay to the base of the Vanport Limestone. This seems an undesirable alteration as the Vanport can easily be treated as a member of the Clarion Formation.

"Connoquenessing"

The Connoquenessing, as originally defined and as generally used since, is discriminated on the basis of its lithologic content. Although it contains the Quakertown coal bed and associated shales in the middle, the critical lithologies are an upper and lower sandstone. The name Connoquenessing applies only in places where the sandstone lithology occurs. Where the sandstone disappears, the laterally equivalent units by definition are part of the subjacent Sharon, or superjacent Mercer units, or are unnamed units.

Williams (1960) raised the Connoquenessing to formation rank. Although Williams' description is brief and generalized with no specific sections given, it appears that his usage equates the formation with the upper and lower Connoquenessing sandstones plus the intervening Quakertown. Williams' Connoquenessing Formation is, therefore, defined on lithologic homogeneity. He does not specify the treatment of any non-sandstone lateral equivalents of the Connoquenessing Formation. Carswell and Bennett (1963) and Poth (1963) also accorded the Connoquenessing Formation status on a similar lithologic basis (Figure 2). It is the writer's feeling that the Connoquenessing, or, better, the upper and lower Connoquenessing sandstones should be treated as members of a broader, more inclusive formation defined by key beds.

"Freeport"

Since at least 1880 the Freeport has been defined as those rocks between the top of the upper Kittanning coal and the top of the upper Freeport coal. It is the uppermost subdivision of the Allegheny and is usually and logically treated as a formation.

The Freeport Formation is defined by key beds and not by lithologic homogeneity.

"Homewood"

The Homewood is a lithologically defined unit composed specifically of sandstone. Where the Homewood sandstone grades into another lithology, the latter is included in either the subjacent Mercer units or in an unnamed (and generally unrecognized) unit above.

Regardless of the terms appended, the Homewood sandstone was rarely, if ever, employed at a rank greater than member until specifically termed a formation by Carswell and Bennett (1963) and Poth (1963) (Figure 2). Carswell and Bennett also modified the Homewood to include the unnamed shales lying between the sandstone and the base of the Brookville underclay above. This, in effect, anchored the top of the Homewood Formation to a key bed, while leaving the base defined on lithology. Obvious difficulties ensue where the sandstone facies disappears.

It would seem preferable to keep the Homewood sandstone as a member.

"Kittanning"

The Kittanning is the middle of three subdivisions of the Allegheny Group and is generally and logically considered a formation. The Kittanning Formation is usually defined as those rocks between the base

of the lower Kittanning underclay and the top of the upper Kittanning coal. As such it is defined by key beds.

Certain difficulties surrounding the boundary between the Kittanning and Clarion Formations are discussed in the "Clarion" section.

Carswell and Bennett (1963) and Poth (1963) modified the Kittanning Formation by extending it downward to the top of the Vanport Limestone, thereby including in it some strata generally assigned to the Clarion Formation.

"Mercer"

In practice the Mercer is an interval of miscellaneous lithologies bounded by the subjacent upper Connoquenessing sandstone and the superjacent Homewood sandstone. It cannot solely be considered a unit bounded by the upper Connoquenessing and Homewood sandstone key beds, however, as its usage continues where those sandstones disappear laterally. In such case, the Mercer simply expands to take up their missing position. In an extreme case, it could expand to the point where it is equivalent to the entire Pottsville Group.

Williams (1960) used the term Mercer Formation without any clear definition of it. In his Figure 2, Williams shows the Mercer Formation extending from the base of the lowest Mercer underclay to the base at the lowest Clarion underclay. In his text (p. 1293), however, he defines the underlying Connoquenessing Formation as being restricted to the upper and lower Connoquenessing sandstones (plus the intervening Quakertown coal and shales), and the Mercer Formation as an overlying sequence of variable lithologic composition. It is not clear if the non-sandstone lateral equivalents of the Connoquenessing Formation are to be assigned to the Mercer Formation (and thus extend the Mercer below the lowest Mercer clay) or are simply not to be included in any unit.

Carswell and Bennett (1963) and Poth (1963) also utilized the Mercer as the non-sandstone units between the Homewood and upper Connoquenessing sandstones and raised it to formation rank.

"Olean"

The Olean conglomerate has been treated essentially as a member of the Pottsville and is usually (and perhaps incorrectly) equated to the Sharon conglomerate.

"Sharon"

The name Sharon has been assigned to several closely associated stratigraphic units, as Sharon coal, Sharon shale, Sharon conglomerate,

etc. The above have been treated as equivalent to the modern term member or bed as used in the 1961 Code of Stratigraphic Nomenclature. Carswell and Bennett (1963) define a Sharon Formation which is identical to the Sharon shales and conglomerate of previous usage. This use is vague and ambiguous, particularly the relation of its lower boundary with respect to the base of the Pottsville Group.

"Vanport"

The Vanport is a unit defined by its limestone lithology. Except in Carswell and Bennett (1963) and Poth (1963), where it was specifically designated the Vanport Limestone Formation, it has always been treated as a bed or member.

EDMUNDS' 1968 NOMENCLATURE USAGE FOR CENTRAL CLEARFIELD COUNTY, PENNSYLVANIA

In Edmunds (1968) an attempt was made to revise and refine the formational subdivisions of the Pottsville and Allegheny Groups into more useful and in some cases, more precise units (Figure 3). The revision was done so as to alter previous nomenclature as little as possible. All units were based on key beds and not on specific lithologic homogeneity. The following is the stratigraphic nomenclature as used in Edmunds (1968):

Conemaugh Group — All rocks between the top of the upper Freeport coal and the base of the Pittsburgh coal.

Allegheny Group — All rocks between the base of the Clarion no. 1 underclay and the top of the upper Freeport coal.

Freeport Formation — All rocks between the base of the lower Freeport underclay and/or limestone and the top of the upper Freeport coal.

"Upper Kittanning" Formation — All rocks between the base of the upper Kittanning underclay and/or limestone and the base of the lower Freeport underclay and/or limestone.

"Middle Kittanning" Formation — All rocks between the base of the middle Kittanning underclay and the base of the upper Kittanning underclay and/or limestone.

"Lower Kittanning" Formation — All rocks between the base of the lower Kittanning no. 1 underclay and the base of the middle Kittanning underclay.

Clarion Formation — All rocks between the base of the Clarion no. 1 underclay and the base of the lower Kittanning no. 1 underclay.

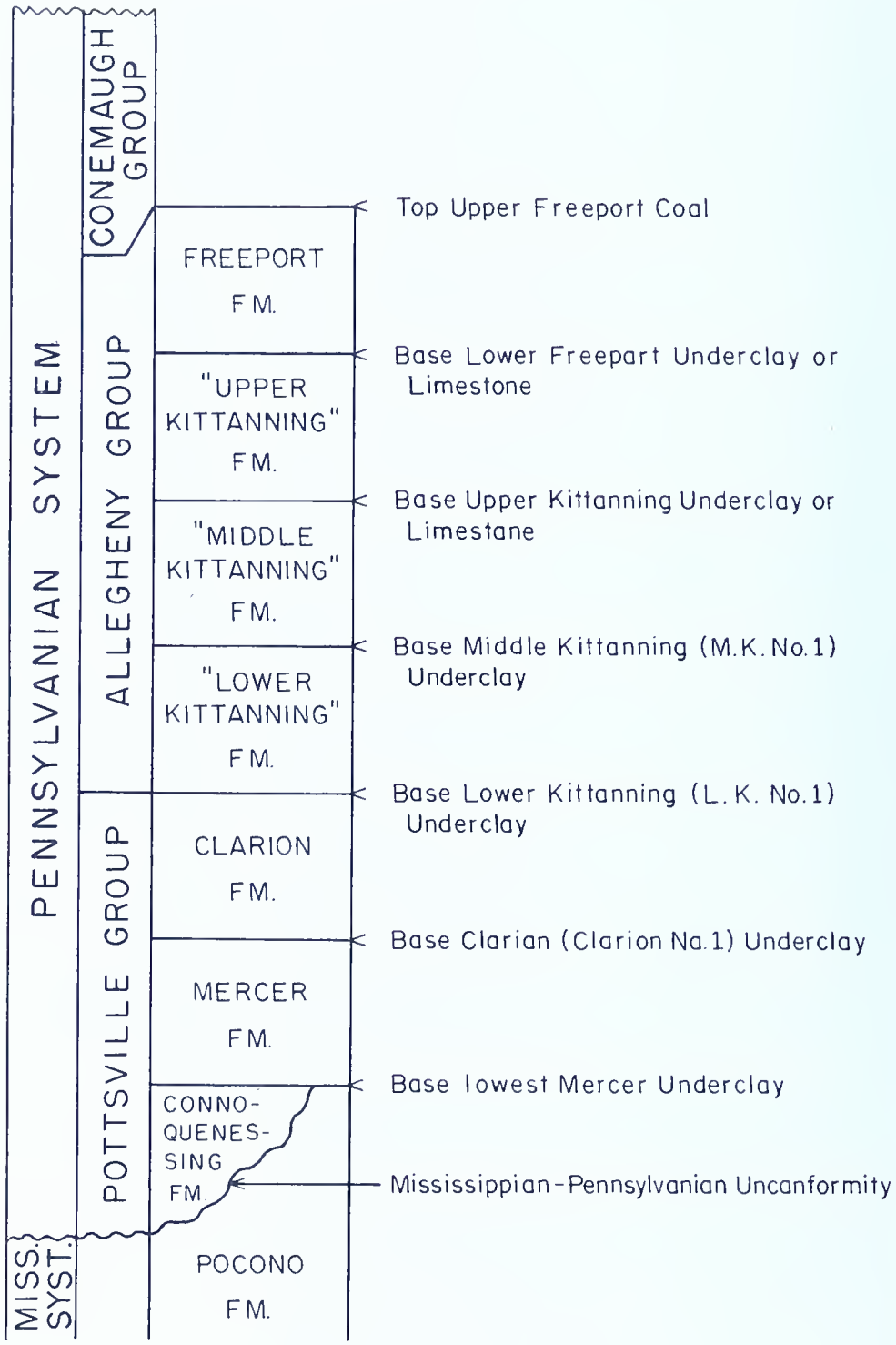


Figure 3. Stratigraphic column used by Edmunds (1968) for the lower part of the Pennsylvanian of Clearfield County, Pennsylvania.

Pottsville Group — All Pennsylvanian age rocks below the base of the Clarion no. 1 underclay (and in effect above the Mississippian - Pennsylvanian unconformity).

Mercer Formation — All rocks between the base of the lowest Mercer underclay (including hard clay) and the base of the Clarion no. 1 underclay.

Connoquenessing Formation — All Pennsylvanian rocks below the lowest Mercer underclay.

The following comments apply to nomenclature in Edmunds (1968):

Conemaugh, Allegheny, and Pottsville Groups — not changed from customary usage.

Freeport Formation — As employed in Edmunds (1968) the term Freeport represents an unjustifiable redefinition of the well-established usage as specified in Article 14 of the the 1961 Code of Stratigraphic Nomenclature.

"Lower Kittanning", "middle Kittanning", and "upper Kittanning" Formations — These are informal units named for the principal coal bed included in each. They were to be left in an informal state until the applicability had been more widely established. Further investigation has shown that they are valid over most of Clearfield County; and, with the possible exception of the "lower Kittanning" Formation, probably well beyond. The writer believes that it is now desirable to formally name the units.

Clarion Formation — The Clarion Formation of Edmunds (1968) was intended to correspond exactly to the general usage of the term. Edmunds placed the base of the unit below the Clarion no. 1 underclay. Clarion no. 1 coal appears to be the seam most nearly equivalent to the Brookville coal. The upper boundary has presented a more notable problem. The lower Kittanning coal of the area consists of four seams (numbered 1 through 4 upward) which coalesce into one thick lower Kittanning seam. The top of the Clarion Formation was, therefore, placed at the base of the underclay below lower Kittanning no. 1 coal. Careful tracing westward of the lower Kittanning no. 1 coal and underclay has strongly indicated that west of Clearfield County the lower Kittanning no. 1 coal disappears or becomes very obscure and the main mined lower Kittanning coal is in fact the no. 3 split. Inasmuch as the Clarion Formation to the west almost surely extends to the base of the lower Kittanning no. 3 underclay, the impending inequivalence is obvious. This unit as used in Edmunds (1968) should be renamed.

Mercer Formation — The Mercer Formation as used in Edmunds (1968) differs in two important respects from the usual usage. As used by Edmunds, the Mercer Formation includes the Homewood sandstone as a member, and in addition, the Mercer Formation is bounded top

and bottom by key beds. The usual usage considers the Mercer as a unit of miscellaneous lithologies bounded by the Homewood Sandstone above and the Connoquenessing Sandstone below. Edmunds' Mercer should be renamed.

Connoquenessing Formation — Inasmuch as the Connoquenessing Formation of Edmunds (1968) is almost entirely sandstone, it would superficially appear to differ little from the generally used term "Connoquenessing Sandstone". In fact, however, Connoquenessing sandstone is a unit based on specific lithology (i.e. sandstone composition) while Edmunds' Connoquenessing Formation is based on the key-bed principle and is thus totally different in concept from the original meaning of Connoquenessing, and is, therefore, improper. This unit must be renamed.

NEW LITHOSTRATIGRAPHIC NOMENCLATURE

GENERAL COMMENTARY

All of the newly defined formations are lithostratigraphic and based on the key-bed principle. Except for the actual key beds no specific lithology is required.

The decision to base all formational rank units on key beds stems from the fact that only a few lithologically homogeneous units are sufficiently thick and laterally extensive to even marginally qualify for formation status. The remainder of the column must in any case be completed with units based on key beds. A mixture of formations in part based on key beds and in part on homogeneous lithology results in odd pieces of the total column being left out and is confusing and imprecise.

All things considered, the coal beds are generally the best key beds available. In the past, many formation boundaries were placed at the base of underclays associated with coals. The coal seams, however, generally represent a much more discrete lithologic unit than the underclays which are commonly gradational into other lithologies laterally and downward. The coal seams are quite persistent laterally. Because of their economic value, coals are frequently exposed by mining and subject to extensive tracing. In addition, mining records and drill data permit closest mapping control on coal seams. Drill-hole records usually record the coal seams distinctly, but frequently fail to distinguish underclays and other lithologies. In the construction of geologic maps, it is the coal seams which are initially plotted and then adjustments are made from them to locate formational boundaries defined on other lithologic units. Furthermore, lines representing the contacts of formations bound-

ed by coal seams show the outcrop traces of those coals on the map, an important consideration in the economic use of such a map.

As mentioned above, the units chosen as key beds are generally present within the area under consideration. Their absence in some places is ascribed to one of two causes: 1) nondeposition or 2) subsequent erosional removal. In most places where a unit is missing by nondeposition, its stratigraphic position can still be determined in a good exposure. A missing coal horizon can usually be equated with the top of its underclay zone. Even where both coal and underclay are lacking, their position can occasionally be determined by the recognition of normally superjacent and subjacent beds. Where the key bed is missing by unconformity, that unconformity in effect replaces the key bed as the formation contact.

With two exceptions, all of the newly defined formation boundaries are based on coal seams. These exceptions are the unconformity at the base of the Pennsylvanian rocks and a single underclay thought to be preferable as the key bed.

The new units are intended for use initially in Clearfield County, and should be extended outward by careful studies into other areas. The names applied to the key beds are those employed in Edmunds (1968). In general, there seems to be no serious difficulty in correlating the key beds of Clearfield County to similarly named units elsewhere. However, in a case such as the Brookville coal, (Clarion no. 1 coal of Edmunds, 1968) where correlations are traditionally obscure, considerable care should be exercised in indicating equivalence.

The following benefits are believed to accrue from the use of the new formations:

1. They provide a more detailed subdivision of the Allegheny Group — five formations as opposed to the previous three. This allows the particular intervals to be more specifically delineated on geologic maps (particularly 7½-minute scale) and segregates and more clearly delimits the intervals for purposes of discussion.
2. In the case where a key bed is locally undefinable, the effect on the mappability of the defined units will be less extensive with the new formations. For example, should the upper Kittanning coal be unmappable in a particular area, the Kittanning and Freeport Formations cannot be separated and should be mapped as Kittanning-Freeport undifferentiated. These two units represent about 80 percent of the Allegheny Group. The same situation with the new formations requires combining units representing only 40 percent of the Allegheny Group.
3. The new formations provide a simplified subdivision of the Pottsville Group, eliminating the present confusing and frequently un-

workable mixture of units defined partly on key beds and partly on lithologic homogeneity.

4. Although all of the new formations are defined uniformly on key beds, locally significant, lithologically homogeneous units (e.g. Homewood sandstone) can be split out as members or beds where desired.
5. The new formation boundaries locate exactly on a map most of the economically important coal and clay beds of the Allegheny and Pottsville Groups.
6. Each of the new formations of the Allegheny Group (except Glen Richey) corresponds, in the author's opinion (Edmunds, 1968), to exactly one cycle of deposition (i.e. one "cyclothem", using that term broadly). The Glen Richey Formation contains exactly one cycle plus the coal (upper Freeport) of the next higher cycle, the remainder of which lies in the Conemaugh Group. The Curwensville Formation of the Pottsville Group (exclusive of the basal underclay) contains one or, more likely, two complete cycles of deposition, but an exact number in any case. The Elliott Park Formation (where present at all) contains exactly one cycle in Clearfield County, but elsewhere probably contains one or two more with the addition of more units at the base. Presuming that the author's genetic interpretations are correct, the new units have the advantage of exactly delimiting the cycles of deposition ("cyclothems"). Even if the genetic interpretations are incorrect, however, the utilitarian aspects of the new formations are not impaired, as genesis is not essential to their definitions.

Figure 4 shows the interrelationship and generalized definitions of the new formations.

DEFINITION OF THE GLEN RICHEY FORMATION

The Glen Richey Formation shall include those rocks occurring above the base of the lower Freeport coal or the base of the lowest split of the lower Freeport coal (lower Freeport no. 1 coal of Edmunds, 1968), and below the top of the upper Freeport coal. In such cases where either the lower Freeport coal (lower Freeport no. 1 coal) or the upper Freeport coal is locally missing through nondeposition, the position of its horizon shall be the equivalent boundary. If either the lower Freeport coal (lower Freeport no. 1 coal) or the upper Freeport coal is missing locally by unconformity the line of the unconformity shall be the boundary.

The name "Glen Richey" is from the village of Glen Richey, Lawrence Township, Clearfield County, Pennsylvania.

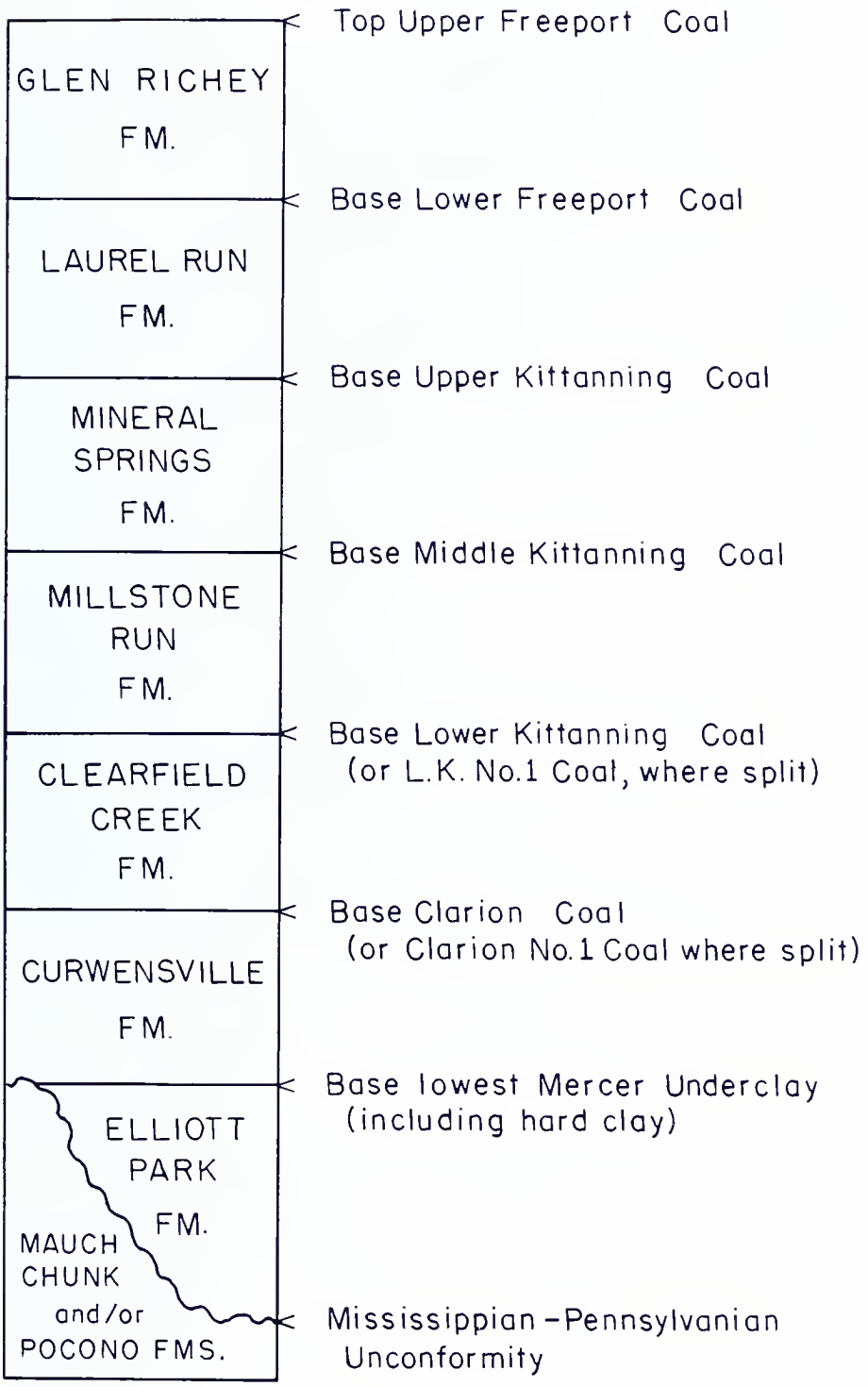


Figure 4. Stratigraphic column showing the new formations created for use in Clearfield County, Pennsylvania.

DEFINITION OF THE LAUREL RUN FORMATION

The Laurel Run Formation shall include those rocks occurring above the base of the upper Kittanning coal and below the base of the lower Freeport coal or the base of the lowest split of the lower Freeport coal (lower Freeport no. 1 coal of Edmunds, 1968). If either the upper Kittanning coal or the lower Freeport coal is locally missing through nondeposition, the position of its horizon shall be the boundary. If either the upper Kittanning coal or the lower Freeport coal (lower Freeport no. 1 coal) is locally missing by unconformity, the line of the unconformity shall be the boundary.

The name "Laurel Run" is from Laurel Run and its tributary Little Laurel Run, Decatur Township, Clearfield County, Pennsylvania.

DEFINITION OF THE MINERAL SPRINGS FORMATION

The Mineral Springs Formation shall include those rocks occurring above the base of the middle Kittanning coal and below the base of the upper Kittanning coal. If the middle Kittanning coal or the upper Kittanning coal is missing locally through nondeposition, the position of its horizon shall be the boundary. If the middle Kittanning coal or the upper Kittanning coal is locally missing by unconformity, the line of the unconformity shall be the boundary.

The name "Mineral Springs" is taken from the village of Mineral Springs, Bradford Township, Clearfield County, Pennsylvania.

DEFINITION OF THE MILLSTONE RUN FORMATION

The Millstone Run Formation shall include those rocks occurring above the base of the lower Kittanning coal or the base of the lowest split of the lower Kittanning coal (lower Kittanning no. 1 coal of Edmunds, 1968) and below the base of the middle Kittanning coal. If either the lower Kittanning coal (lower Kittanning no. 1 coal) or the middle Kittanning coal is locally missing through nondeposition, the position of its horizon shall be the boundary. If either the lower Kittanning coal (lower Kittanning no. 1 coal) or the middle Kittanning coal is locally missing by unconformity, the line of the unconformity shall be the boundary.

The name "Millstone Run" is from Millstone Run, a tributary of the Susquehanna River, in Bradford Township, Clearfield County, Pennsylvania.

DEFINITION OF THE CLEARFIELD CREEK FORMATION

The Clearfield Creek Formation shall include those rocks occurring between the base of the Clarion coal or the base of the lowest split of the Clarion coal (Clarion no. 1 coal of Edmunds, 1968) and below the base of the lower Kittanning coal or the base of the lowest split of the lower Kittanning coal (lower Kittanning no. 1 coal of Edmunds, 1968). If either the Clarion coal (Clarion no. 1 coal) or the lower Kittanning coal (lower Kittanning no. 1 coal) is locally missing through nondeposition, its horizon shall be the boundary. If the Clarion coal (Clarion no. 1 coal) or the lower Kittanning coal (lower Kittanning no. 1 coal) is locally missing by unconformity, the line of the unconformity shall be the boundary.

The name "Clearfield Creek" is from Clearfield Creek, Clearfield County, Pennsylvania.

DEFINITION OF THE CURWENSVILLE FORMATION

The Curwensville Formation shall include those rocks occurring above the base of the lowest Mercer underclay (including hard clay) and below the base of the Clarion coal or the base of the lowest split of the Clarion coal (Clarion no. 1 coal of Edmunds, 1968). If either the lowest Mercer underclay or the Clarion coal (Clarion no. 1 coal) is locally missing through nondeposition, its horizon shall be taken as the equivalent boundary. If either the lowest Mercer underclay or the Clarion coal (Clarion no. 1 coal) is missing by unconformity, the line of the unconformity shall be the boundary.

Because of the highly irregular nature of the Mercer coals and the somewhat more regular nature of the lowest Mercer underclay and hard clay, it is felt desirable to employ the underclay as the key bed rather than a coal seam.

The name "Curwensville" is taken from Curwensville Borough, Clearfield County, Pennsylvania.

DEFINITION OF THE ELLIOTT PARK FORMATION

The Elliott Park Formation shall include those rocks which lie below the base of the lowest Mercer underclay (including hard clay) and which, in Clearfield County, unconformably overlie the Mauch Chunk or Pocono Formations. If the lowest Mercer underclay is missing by nondeposition, its horizon shall be the boundary. If the lowest Mercer

underclay is missing by unconformity, the line of the unconformity shall be the boundary.

The name "Elliott Park" is taken from S. B. Elliott State Park, Pine Township, Clearfield County, Pennsylvania.

RELATIONSHIP OF THE NEW FORMATIONS TO THE POTTSVILLE, ALLEGHENY, AND CONEMAUGH GROUPS AND TO OTHER PREVIOUS USAGE

Figure 5 shows the equivalence between the new formations and the Pottsville, Allegheny, and Conemaugh Groups. In order to achieve the equivalence shown in Figure 5, the Pottsville and Allegheny Groups are modified to the extent that the rocks between the base of the Brookville-Clarion no. 1 coal and the base of the Brookville-Clarion no. 1 underclay are transferred from the Allegheny Group to the Pottsville Group. Figure 6 shows the relation between the new nomenclature proposed here and previous terminology.

TYPE SECTIONS

Glen Richey Formation Type Section

Location: Pike Township, Clearfield County, Pennsylvania, 2,000 feet east of 78° 30′, 500 feet south of 40° 57′ 30″. Glen Richey 7½-minute quadrangle. Section taken from a double strip mine.

Measured section (see Figure 7):	Thickness Feet	Thickness Inches
- (Claystone, dark-gray to medium-dark-gray, 1- to 2-inch beds, conchostrachons).		
8. *Upper Freeport coal.*	2	4
7. *Underclay,* medium-light-gray.	2	
6. *Limestone,* medium-dark-gray, lumpy, irregular top and bottom.	1	
5. *Sandstone,* very fine-grained to fine-grained, very clayey, medium-yellow-gray to green-gray, some shale pebble conglomerate, irregular bedding, coal stringers.	16	
4. *Silt shale,* dark-gray, coal stringers, irregular bedding.		6

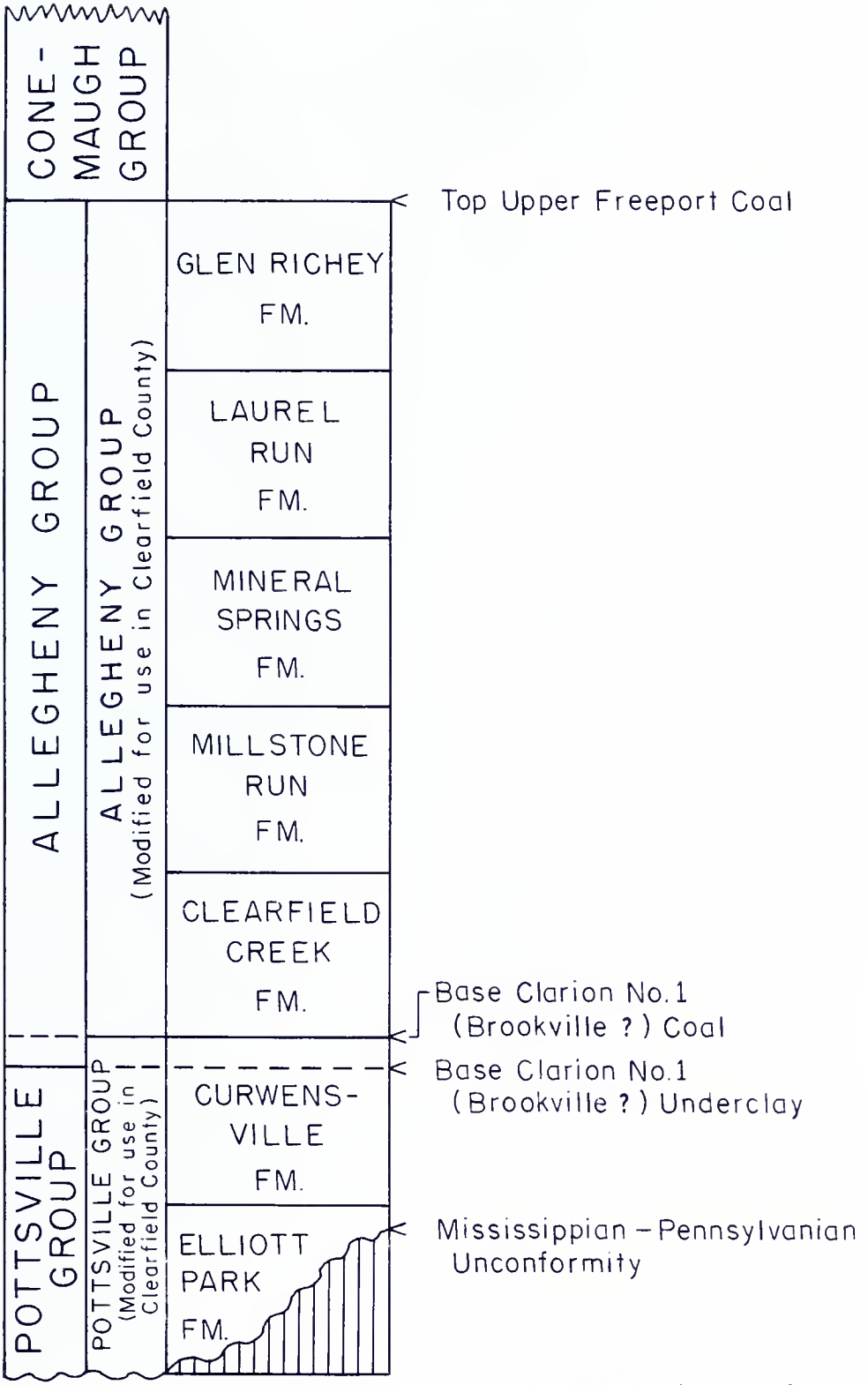


Figure 5. Stratigraphic column showing the presumed relation between the new formations and the Conemaugh and revised Allegheny and Pottsville Groups.

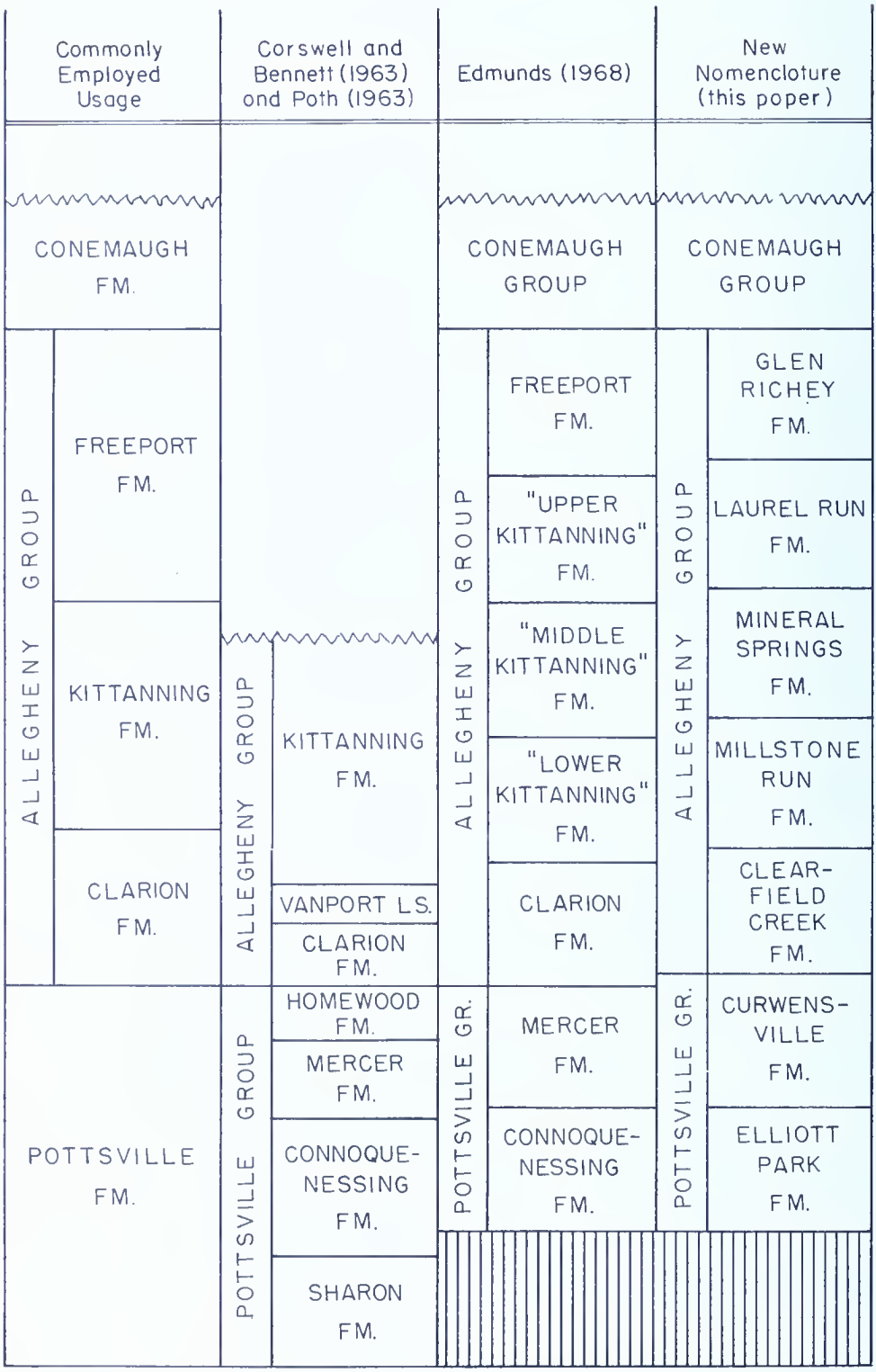


Figure 6. Summary of the stratigraphic nomenclature usage for the lower part of the Pennsylvanian of western Pennsylvania.

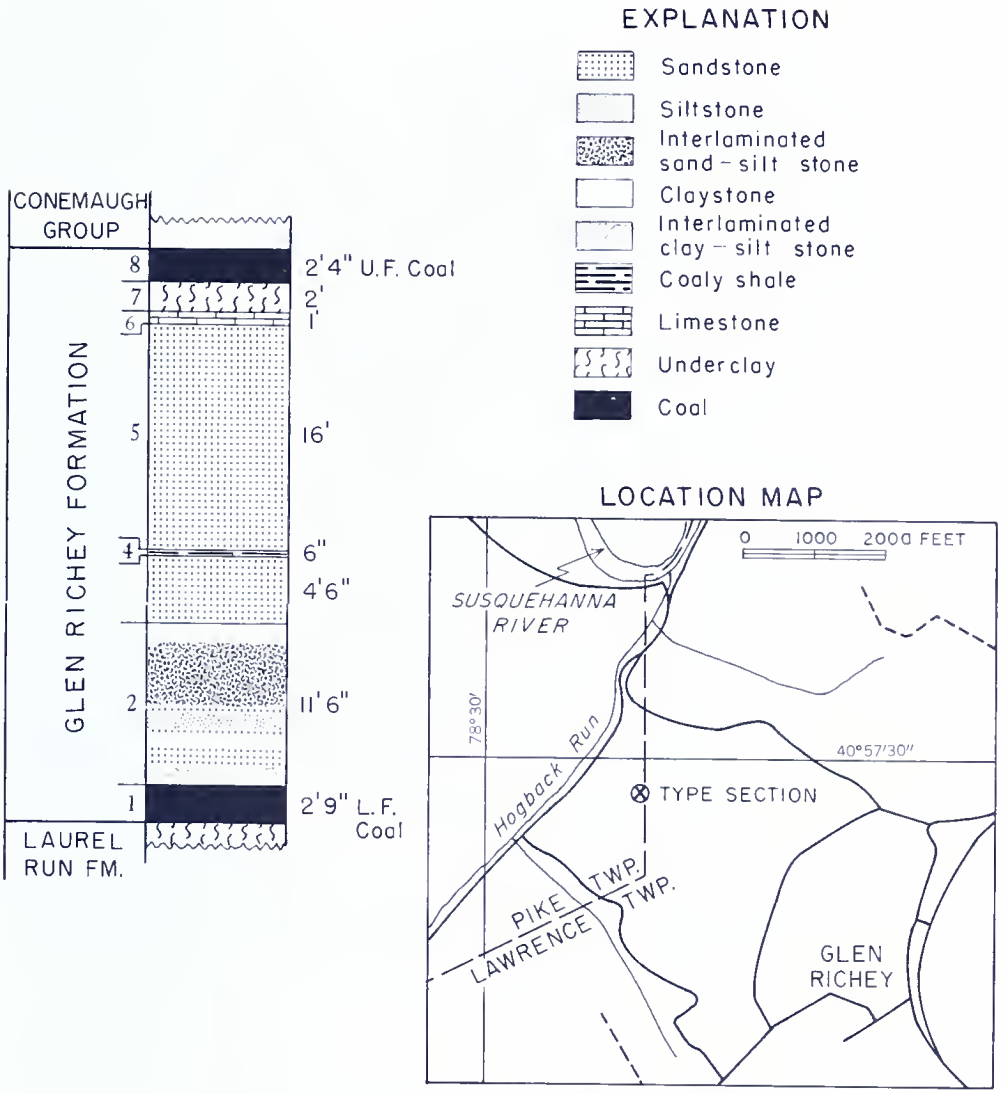


Figure 7. Glen Richey Formation, type section.

	Thickness *Feet*	*Inches*
3. *Sandstone,* fine-grained to medium-grained, medium-light-gray, micaceous, coal fragments, 2- to 6-inch beds (2 feet); grades up to *sandstone,* very fine-grained, silty, medium-light-gray-brown, coal fragments, irregular 6-inch to 1-foot beds (2½ feet).	4	6
2. *Claystone,* silty, black, dense, ½- to 1-inch beds (½ foot); grades up to *interlaminated silt-clay stone,* medium-light-gray and me-		

		Thickness Feet	Inches
	dium-dark-gray laminae, ½- to 4-inch beds (1 foot); grades up to *sandstone*, very fine-grained, clayey, medium-light-gray (1 foot); grades up to *claystone*, silty, medium-dark gray (1 foot); grades up to *sandstone*, very fine-grained, medium-gray, clayey (½ foot); grades up to *siltstone*, clayey, medium-dark-gray, 1- to 3-inch beds (1 foot); grades up to *sandstone*, very fine-grained to fine-grained, clayey, medium-gray (½ foot); grades up to *interlaminated sand-silt stone*, dark-gray and medium-light-gray laminae, plant fragments, 1- to 6-inch beds (4½ feet); grades up to *claystone*, silty, medium-gray-green (1½ feet).	11	6
1.	*Lower Freeport coal*, persistent 2-inch claystone parting 3 inches above base.	2	9
-	(Underclay).		

Laurel Run Formation Type Section

Location: Decatur Township, Clearfield County, Pennsylvania, 1,000 feet west of 78° 15′, 4,100 feet south of 40° 55′. Wallaceton 7½-minute quadrangle. Section taken from a strip mine.

		Thickness Feet	Inches
Measured Section (see Figure 8):			
-	(Lower Freeport coal).		
8.	*Underclay*, various shades of gray and olive-gray, rootlets and plant fragments, 2-foot zone 3 feet from top contains *limestone* boulders up to 2 feet in diameter mixed with limonitic underclay.	9	
7.	*Sandstone*, fine-grained, medium-light-gray, one bed, irregular basal contact (½ foot); grades up to *fissile sandstone*, very fine-grained, siliceous, siderite nodules, ¼-inch beds (3 feet); grades up to *silt shale*, medium-dark-gray (1 foot); grades up to *sandstone*, fine-grained, medium-gray, one bed (½ foot);		

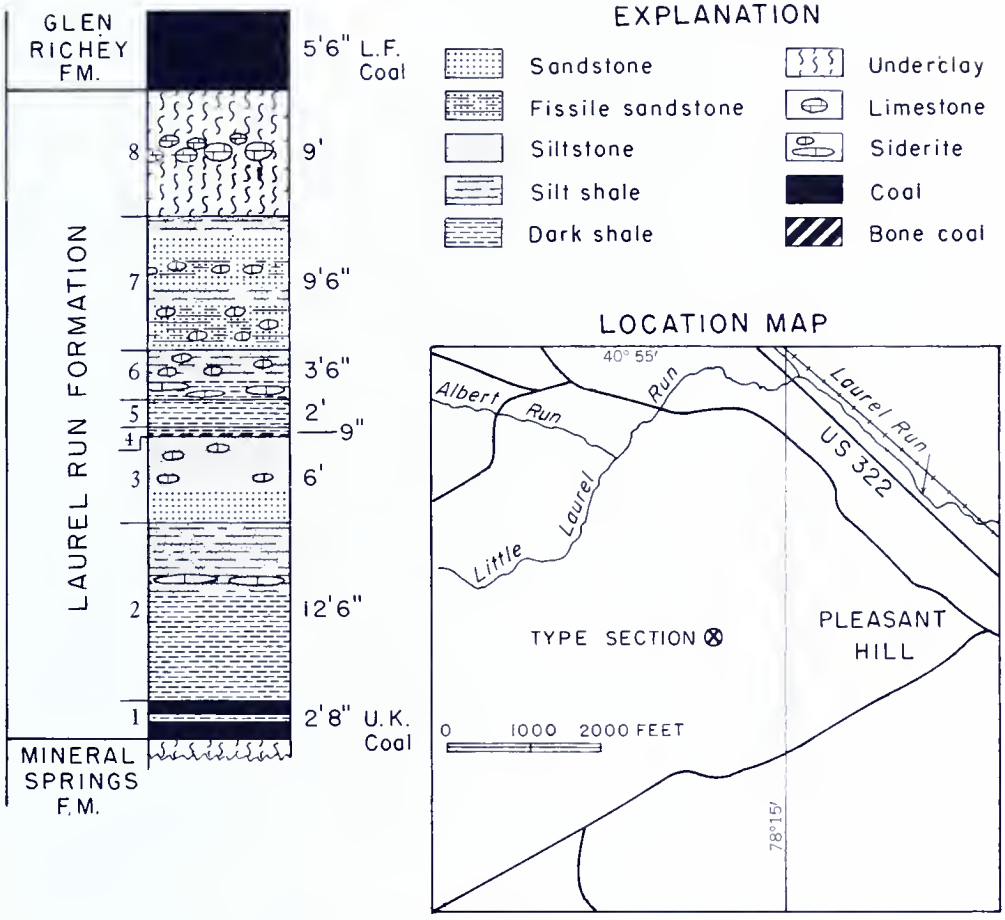


Figure 8. Laurel Run Formation, type section.

		Thickness *Feet*	*Inches*
	grades up to *fissile sandstone*, very fine-grained, medium-light-gray to light-green-gray, ½-inch beds, siderite nodules to 2 inches (1½ feet); grades up to *sandstone*, very fine-grained to fine-grained, dusky-yellow, 1 or 2 beds (2 feet); grades up to *siltstone*, sandy, 2-inch gray-black *clay shale* 8 inches from base, rootlets and plant fragments (1 foot).	9	6
6.	*Clay shale*, black, siderite bands (1½ feet); grades up to *silt shale*, sandy, medium-dark-gray, siderite nodules to 2 inches (2 feet).	3	6
5.	*Clay shale*, black, papery.	2	
4.	*Silt shale*, brown-black to black, carbonaceous, approaches bone, 1-inch *bony coal* at base.		9

		Thickness Feet	Inches
3.	*Sandstone*, very fine-grained, beds grade from ½ inch to 6 inches upward (2½ feet); grades up to *siltstone*, medium-dark-gray to dark-gray, rootlets and plant fragments, siderite nodules (3½ feet).	6	
2.	*Clay shale*, black, papery, few siderite bands (2 feet); grades up to *clay shale*, olive-black to black, plant leaves (5 feet); grades up to *clay shale*, black (½ foot); grades up to *silt shale*, olive-gray to medium-dark-gray, plant fragments, siderite laminae, sandier upward (5 feet).	12	6
1.	*Upper Kittanning coal*, 6-inch black clay shale parting 11 inches from top.	2	8
-	(Underclay).		

Mineral Springs Formation Type Section

Location: Boggs Township, Clearfield County, Pennsylvania, 3,400 feet north of 40°57′30″, 2,100 feet west of 78°20′. Wallaceton 7½-minute quadrangle. Section taken from a strip mine.

		Thickness Feet	Inches
Measured section (see Figure 9):			
-	(Upper Kittanning coal).		
12.	*Underclay*, medium-light-gray, soft.	6	
11.	*Limestone*, medium-brown-gray, solid bed.	1	6
10.	*Underclay*, light-gray, sandy, many *limestone* nodules to 1 foot in lower 6 feet, scattered *limestone* nodules in upper 5 feet, *limestone* is clayey, light-gray.	11	
9.	*Sandstone*, very fine-grained, medium-dark-gray, carbonaceous, ferruginous; grades up into *sandstone*, very fine-grained, very clayey, nonbedded, grades up into unit 10, unconformable on unit 8.	1	
8.	*Clay shale*, medium-light-gray-green, slightly silty, ⅛- to ¼-inch chips, even bedded (11 feet); grades up to *claystone*, medium-light-gray-green, silty, breaks down to very small, irregular chips, plant fragments (2 feet).	13	

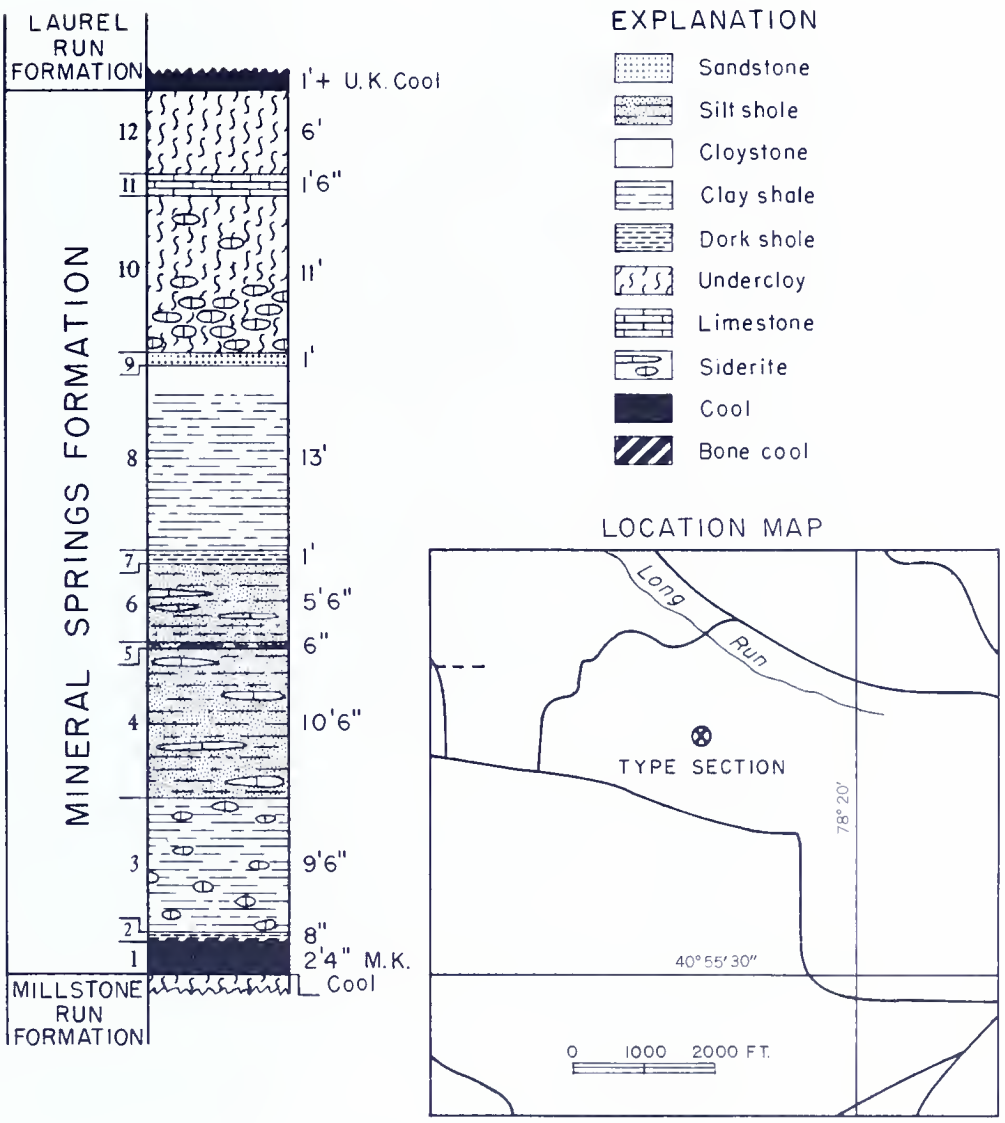


Figure 9. Mineral Springs Formation, type section.

		Thickness	
		Feet	*Inches*
7.	*Silt shale,* black, papery, sulfur flowers and iridescent purple-brown stain on surface.	1	
6.	Interbedded *silt shale,* dark-gray, 1/16- to ½-inch chips, and *siltstone,* medium-gray, ½- to 2-inch beds both with siderite bands and lenses to 2 inches.	5	6
5.	*Silt shale,* dark-gray, iridescent purplish-brown stain on surface, abundant *Lingula* sp.		6

		Thickness Feet	Inches
4.	Interbedded *silt shale, dark-gray,* 1/16- to 1/2-inch chips and *siltstone,* medium-dark-gray, 1/2- to 2-inch beds both with siderite bands and lenses to 2 inches.	10	6
3.	*Clay shale,* medium-dark-gray, thin to papery chips, numerous siderite nodules varying from 1 inch to 6 inches upward.	9	6
2.	Varies from carbonaceous *black shale* to *bone coal.*		8
1.	*Middle Kittanning coal.*	2	4
-	(Underclay).		

Millstone Run Formation Type Section

Location: Bradford Township, Clearfield County, Pennsylvania, 6,600 feet north of 41°00′, 5,400 feet west of 78°15′. Lecontes Mills 7½-minute quadrangle. Section taken from a strip mine.

		Thickness Feet	Inches
Measured section (see Figure 10).			
-	(Middle Kittanning coal).		
13.	*Underclay,* light-gray, hackly, *Stigmaria* and rootlets, siderite nodules (5 feet); grades up to *clay shale,* light-gray, 1/8- to 1/4-inch chips (5 feet); grades up to *underclay* light-gray, hackly, semiplastic, rootlets (3½ feet).	13	6
12.	*Coaly shale,* gray-black to black, plant fragments (lower Kittanning no. 5 coal?).		3
11.	*Clay shale,* dark-gray, 1/32- to 1/8-inch chips, abundant plant fragments and leaves.	6	
10.	*Sandstone,* light-gray, fine-grained, micaceous, dark minerals, one bed.	3	6
9.	*Silt shale,* black, 1/32-inch chips, rare *Orbiculoidea* sp. (6 inches); grades up to *silt shale,* dark-gray, uniform 1/8-inch chips, one or two siderite bands, rare *Orbiculoidea* sp. (10½ feet).	11	
8.	*Coal* (6 inches); grading up to *coaly shale* gray-black (6 inches); grading up to *silt shale,* medium-gray, hackly, rootlets (9 inches); overlain by *coal* (7 inches) (all equal to lower Kittanning no. 4 coal).	2	4

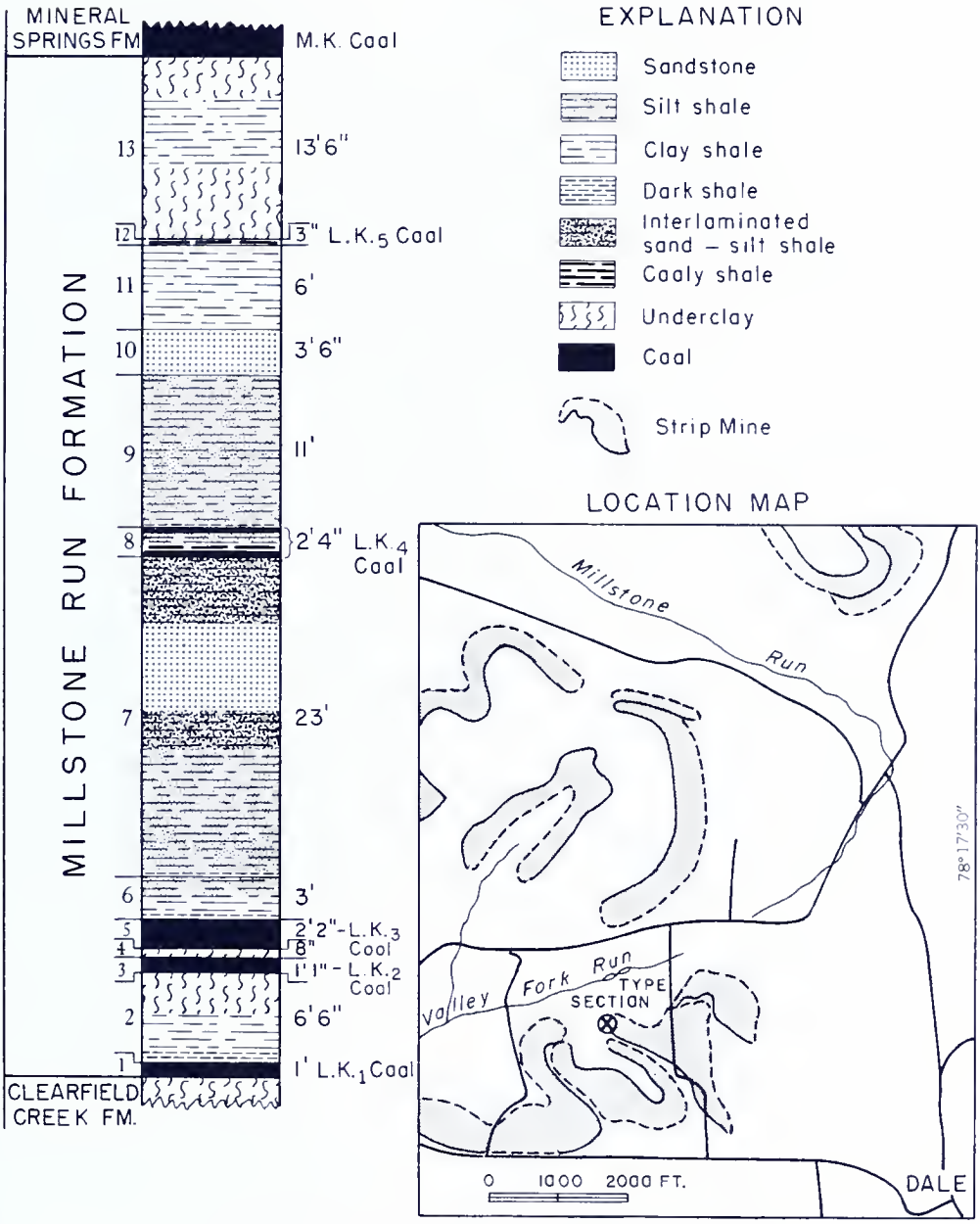


Figure 10. Millstone Run Formation, type section.

7. *Silt shale,* medium-dark-gray, ⅛- to ¼-inch chips, sideritic zones, white sulfate powder (9 feet); grades up to *interlaminated sand-silt shale,* medium-dark-gray to medium-light-gray, ⅛- to ¼-inch chips, sideritic zones, white sulfate powder (3 feet); grades up to *sandstone,* medium-light-gray, silt to very fine-grained sand, ⅛-inch to 1-foot beds, platy, mi-

		Thickness Feet	Inches
	caceous, clay matrix, dark minerals, common plant fragments and leaves (6 feet); grades up to *interlaminated sand-silt shale*, medium-gray (variable), 1/32- to 1/4-inch chips, common plant fragments and leaves, bedding irregular, strong sulfur smell (5 feet).	23	
6.	*Clay shale*, gray-black to dark-gray, 1/32- to 1/4-inch chips, rare plant fragments (6 inches); grades up to *clay shale*, silty, medium-dark-gray, 1/8- to 1/4-inch chips, few small siderite nodules, common plant fragments, some silt laminae (1 foot); grades up to *silt shale*, gray-black, 1/8- to 1/4-inch chips, rare plant fragments, common *Lingula* sp., white sulfate powder (1½ feet).	3	
5.	*Lower Kittanning no. 3 coal.*	2	2
4.	*Underclay*, medium-gray, shaly.		8
3.	*Lower Kittanning no. 2 coal.*	1	1
2.	*Silt shale*, dark-gray, micaceous, carbonaceous, plant fragments (1 foot); grades up to *clay shale*, silty, light-gray (2½ feet); grades up to *underclay*, light-gray, rootlets, *Stigmaria*, hackly (3 feet).	6	6
1.	*Lower Kittanning no. 1 coal.*	1	0
-	(Underclay).		

Clearfield Creek Formation Type Section

Location: Boggs Township, Clearfield County, Pennsylvania, 5,600 feet south of 41°00′, 4,600 feet east of 78°25′. Glen Richey 7½-minute quadrangle. Section taken from a strip mine.

		Thickness Feet	Inches
Measured section (see Figure 11):			
-	(Lower Kittanning no. 1 coal).		
16.	*Clay shale*, medium-dark-gray, 1/4-inch chips, hackly, plant fragments.	1	
15.	*Underclay*, medium-gray grading up to medium-light-gray, top 3 inches medium-dark-gray.	2	6

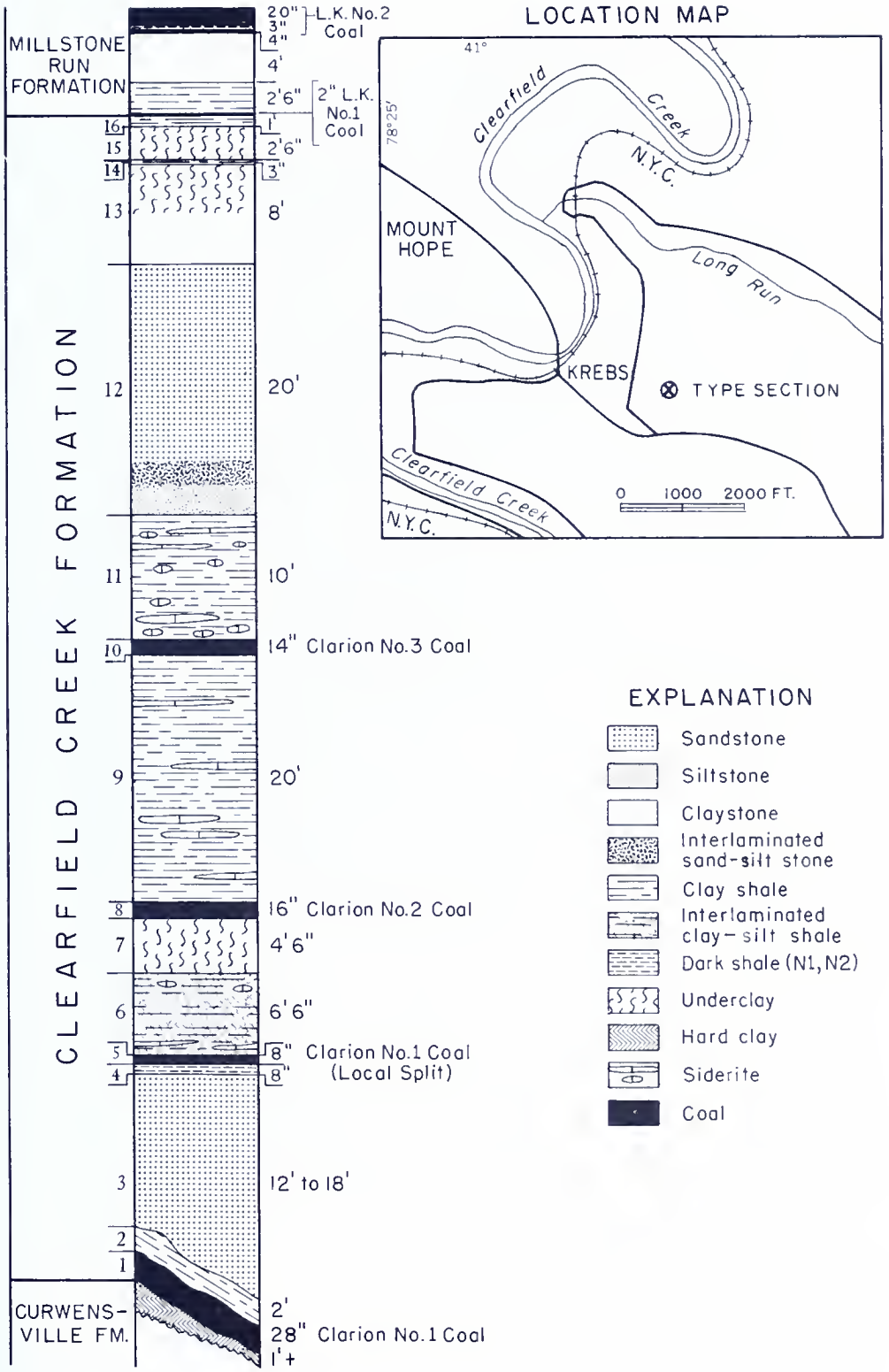


Figure 11. Clearfield Creek Formation, type section.

		Thickness Feet	Inches
14.	*Clay shale*, dark-gray, plant fragments and carbonaceous material.		3
13.	*Claystone*, light-gray to yellowish-gray, ½- to 1-inch beds, grades upward into *underclay*, light-gray except top 6 inches which is dark gray.	8	
12.	*Siltstone*, medium-gray, micaceous, 1- to 4-inch beds, possibly unconformable on unit 11 (2½ feet); grades up to *interlaminated sand-silt stone*, interlaminated light-gray (sand) and medium-gray (silt), 6-inches to 1-foot beds (2 feet); grades up to *sandstone* very fine-grained, light-gray to yellowish-gray to light-olive-gray, irregular 1-inch to 1-foot beds (15½ feet).	20	
11.	*Clay shale*, medium-gray, 1/16- to ¼-inch chips, hackly, becomes silty upward, numerous siderite bands and nodules to 2 inches, *Composita* sp., *Amboceolia planconvexa, Marginiferia muricatina* occur in lower few feet.	10	
10.	*Clarion no. 3 coal*, shaly.	1	2
9.	*Clay shale* to *claystone*, medium-dark-gray, ¼- to 1-inch beds, hackly chips, siderite bands, top 1 foot rootworked and with plant fragments, lower 2 feet contains *Dunbarella whitei, Lingula carbonaria* and plant fragments.	20	
8.	*Clarion no. 2 coal.*	1	4
7.	*Underclay*, light-gray to dark-gray upward.	4	6
6.	*Interlaminated clay-silt shale*, interlaminated medium-gray (silt) and brownish-gray (clay), siltier upward, hackly, ¼- to ½-inch chips, scattered siderite nodules in upper 1 foot, few ¼-inch siderite bands in lower 1½ feet, *Lingula carbonaria* and plant fragments.	6	6
5.	Local *coal* (Possible local split of Clarion 1 or 2) lower 2 inches is bone, rest coal.		8
4.	*Silt shale*, dark-gray to black, subfissile, ⅛-inch chips, many thin carbonaceous laminae.		8
3.	*Sandstone*, fine-grained to medium-grained, medium-light-gray to medium-gray, 6-inch to 4-foot beds, micaceous, coaly stringers and		

		Thickness Feet	Inches
	carbonaceous material (especially lower 1 foot), clay matrix, dark minerals, plant fragments, unconformable on unit 2.	12 to 18	
2.	*Clay shale*, silty, dark-gray, ⅛- to ¼-inch flat chips, plant fragments, possible *Anthraconauta* sp.	2	
1.	*Clarion no. 1 coal.*	2	4

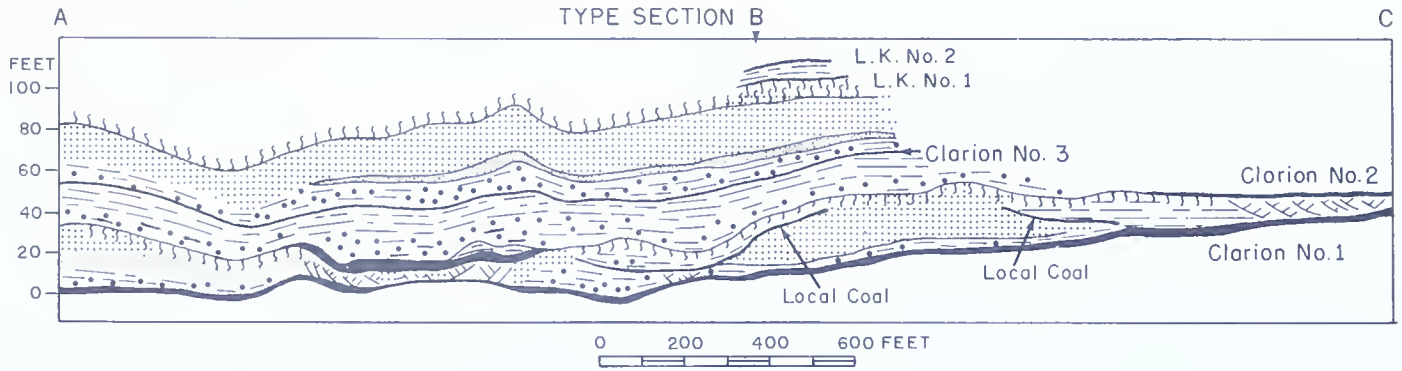
Note: The Clearfield Creek Formation varies internally to a considerable degree in this immediate area. Figure 12 shows the lateral variation from the immediate vicinity of the point where the type section was taken.

Curwensville Formation Type Section

Location: Pike Township, Clearfield County, Pennsylvania, 5,500 feet south of 47°50′30″ and 4,500 feet west of 78°32′30″. Curwensville 7½-minute quadrangle. Section is taken from quarry and adjacent road and railroad cuts.

Measured section (see Figure 13):

		Thickness Feet	Inches
-	(Clarion no. 1 coal).		
4.	*Siltstone*, sandy, medium-gray, blocky, *Stigmaria* (3 feet); grades up to *clay shale*, medium-dark-gray, very fine chips (approaches underclay) (3 feet); grades up to *semihard clay* with some hard clay nodules to 2 feet in diameter, medium-gray, some sandstone and siltstone lenses (3 feet); grades up to *underclay*, silty, medium-light-gray, *Stigmaria* (3 feet).	12	
3.	*Sandstone*, silty, silt to fine-grained sand, medium-light-gray, silica cement, micaceous, dark minerals, some coaly stringers, plant impressions up to trunk size, major point bar beds dip southwest, beds 1 to 4 feet, cut-and-fill structures.	10 to 20	
2.	*Coal.*		2 to 5
1.	*Hard clay*, medium-gray to medium-dark-gray, appears to be mostly high-alumina diaspore block clay, 6-inch to 1-foot beds, hard, splintery to conchoidal fracture, numerous small pinpoint pits containing white clay material.	6 to 9	



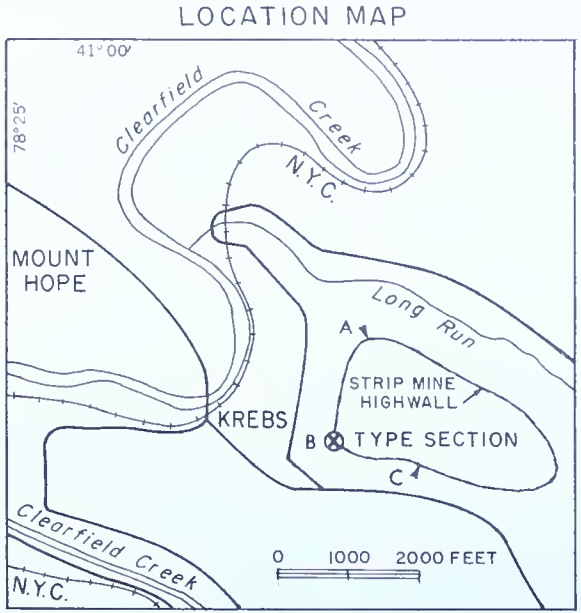


Figure 12. Local internal variability of the Clearfield Creek Formation in the immediate vicinity of the type section.

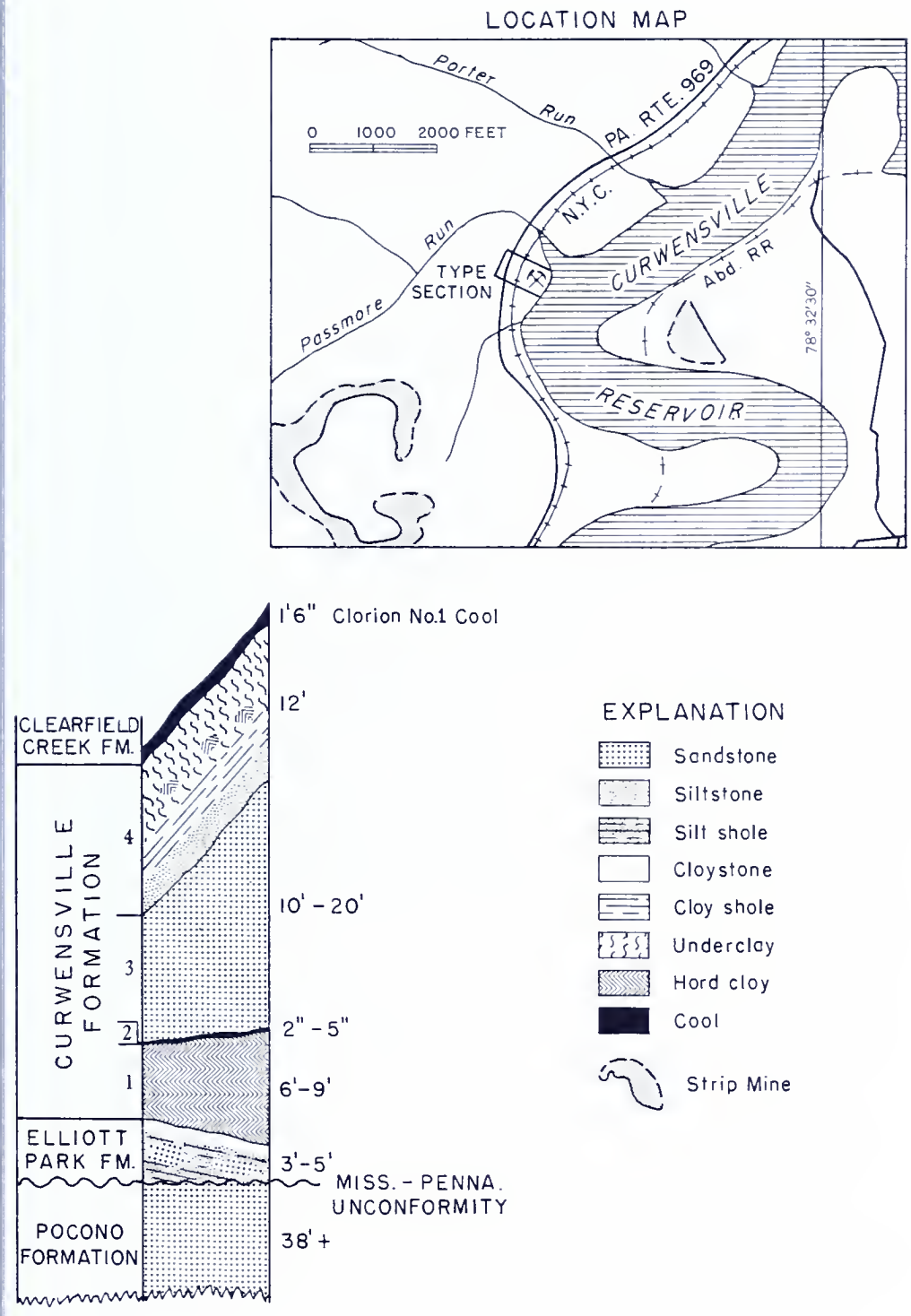


Figure 13. Curwensville Formation, type section.

- (Irregularly interbedded *silt shale*, dark-gray, splintery chips and *siltstone*, sandy, clayey, blocky, gray-brown to dusky-brown; also some *sandstone* very fine-grained, medium-light-gray. Top few inches is *claystone*, medium-gray, hard, numerous pinpoint pits of white clay mineral which weather out leaving the rock surface pitted with many small holes).
- (Mississippian-Pennsylvanian unconformity).
- (Burgoon *sandstone*, fine-grained to very fine-grained, light-gray to very light-gray, beds 6 inches to 5 feet, top 6 feet thinner bedded, cross-bedded (dip S. 50° to 70° E.).

Elliott Park Formation Type Section

Location: Lawrence Township, Clearfield County, Pennsylvania, 4,900 feet south of 41°05′ and 4,000 feet east of 78°30′. Clearfield 7½-minute quadrangle. Exposure in road cut along Interstate Route 80.

	Thickness *Feet*	*Inches*
Measured section (see Figure 14):		
- (Mercer coal and underclay blossom).		
4. Interbedded *siltstone* and very fine-grained *sandstone*, medium-dark-gray to gray-black, micaceous, thin-bedded, plant fragments (carbonizations), *Stigmaria*.	14	
3. *Sandstone*, fine-grained to medium-grained, very light-gray to light-gray to light-brownish-gray, dark minerals, dark-stained iron zones and bands, micaceous, rare plant fragments, beds 2 inches to 2 feet.	30 to 50	
2. *Coal*, shaly, bony, present as occasional pockets (Quakertown?).		0 to 3
1. Interbedded *sandstone*, fine-grained to very fine-grained, siliceous, micaceous, very light-gray but with many small pits containing dusky-red clay which gives the rock a moderately pink to pale-red hue, lumpy, plant fragments; and *clay shale*, mottled pink and yellow-gray, lumpy, *Neuropterous* sp., *Cordaicarpus* sp.	0 to 6	

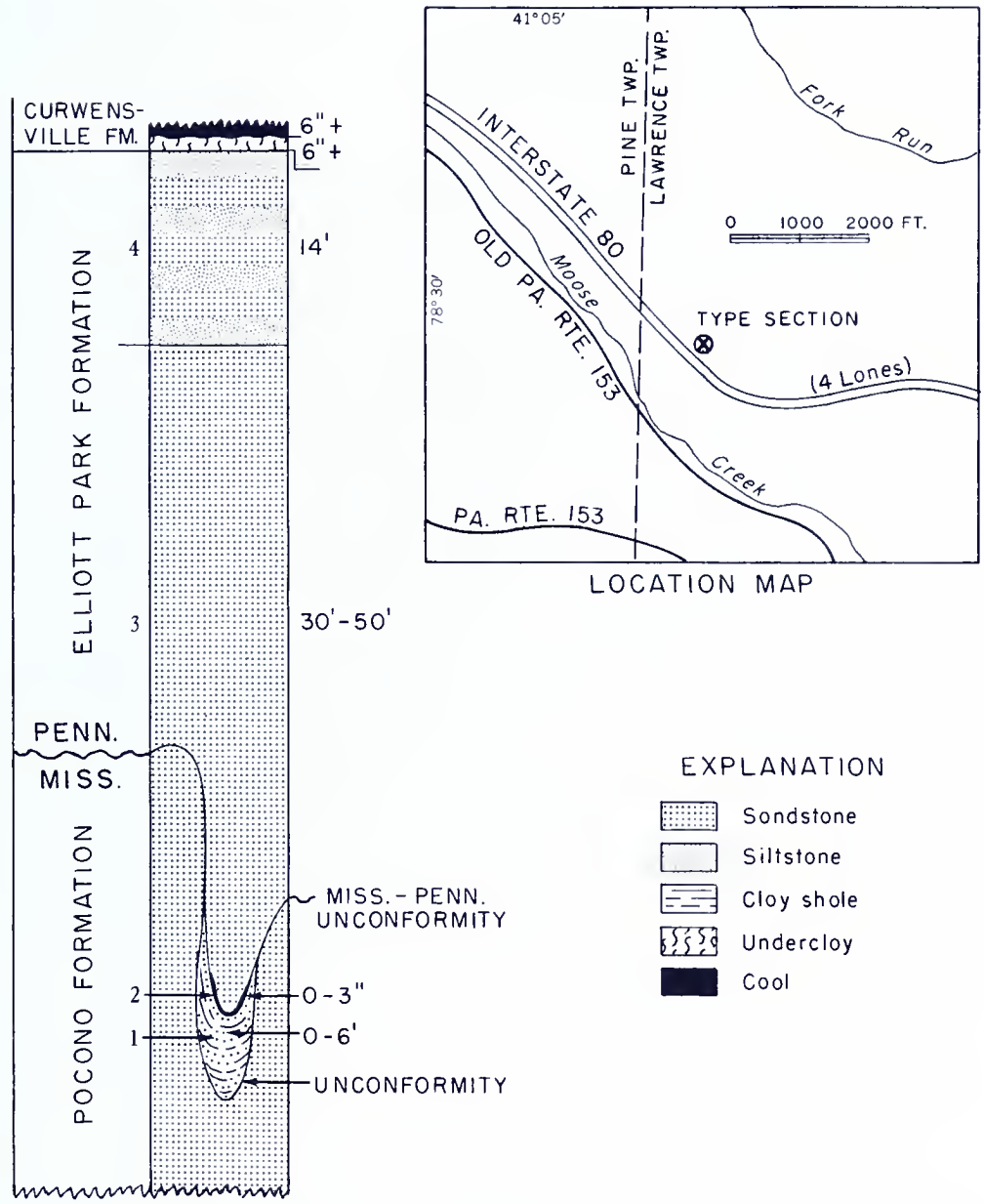


Figure 14. Elliott Park Formation, type section.

- (Mississippian-Pennsylvanian unconformity).
- (Burgoon *sandstone*, fine-grained to very fine-grained, very light-gray, occasionally medium-light-gray, rare dark minerals, some orange-brown iron staining, contains some beds of dark-gray *siltstone* to *silt shale*, with plant fragments and leaves including *Adiantites spectabilis*.

See Edmunds and Berg (in press) for a complete description of the section exposed along Interstate Route 80 between Clearfield and Elliott Park.

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